Home Pasteurization of Milk

LLOYD ARNOLD, M. D., AND C. J. GUSTAFSON

Research Laboratories, State Department of Public Health and College of Medicine, University of Illinois, Chicago, Ill.

THE advantages of pasteurized milk need not be dwelt upon in this JOURNAL. Our purpose is to report experiments upon the use of vacuum and insulated heat retaining bottles to pasteurize milk in small quantities suitable for home use. This is a part of a program of the Illinois State Department of Public Health to reduce infant mortality in communities too small to enjoy the benefits of commercially pasteurized milk.

Illinois has an approximate population of 4 million people living outside of the city of Chicago, at least 70 per cent of which uses raw milk.

A recording thermometer was used for these experiments. The readings were checked with certified mercury thermometers. Water, milk and other fluids were heated to various temperatures and placed in vacuum vessels of various sizes and types, and the heat retaining efficiency of each vessel graphically recorded on a circular ruled paper by a moving writing point, moved by a time clock. The results are presented in tables, calculated from averages from the time and temperature graphs. The temperatures varied from 100° to 200° F. We are only concerned in this article with those temperatures that are of practical use in the pasteurization of milk for human consumption.

Milk was heated in an open vessel to a given temperature, then placed in a vacuum bottle and the heat retaining efficiency of the closed vacuum vessel determined. Such a vessel can act as an incubator under certain conditions. The object of our experiments was to find a vessel of the proper size that would retain the heat of the milk for the longest period before it served as an incubator for its contents.

This part of the problem divided itself into 3 factors: (1) duration of the holding or pasteurization temperature; (2) length of time that the milk would be warm but wholesome; (3) time when the vessel cooled to a degree that would incubate its contents.

When the continuous recording thermometer is used over a long

TABLE I

TOTAL NUMBER OF EXPERIMENTS CARRIED OUT USING MILK IN VACUUM AND INSULATED VESSELS OF VARIOUS SIZES WITH CONTINUOUS GRAPHIC TEMPERATURE RECORDS

	Experiments
½ pint vacuum bottle	10
1 pint vacuum bottle	22
1½ pint vacuum bottle	14
1 quart vacuum bottle	32
2 quart insulated bottle	12
1 gallon insulated jug	10

TABLE II

TEMPERATURE RECORDS OBTAINED WITH CERTIFIED MERCURY THERMOMETER AND RECORDING THERMOMETER IN SAME 1 QUART VACUUM BOTTLE AT HOURLY PERIODS FOR 13 HOURS. BOTH THERMOMETERS REGISTERED 145° F. AT BEGINNING OF EXPERIMENT

Hours	1	2	3	4	5	6	7	8	9	10	11	12	13
Mer. Therm. ° F.	142.5	140.5	138	136.5	134	132	130	137.5	125.5	123	121.5	118.5	117
Rec. Therm. ° F.	141	138	134.5	131	129	126	124	122	119.5	117.5	115.5	113	111

period there is a certain loss in heat in the conducting system. Table II shows the differences in the readings obtained upon the same vacuum bottle with the use of the continuous recording thermometer and a certified mercury thermometer for 13 hours. Table III indicates the heat retaining properties of 6 vacuum and insulated vessels used. These are the averages obtained from 100 experiments indicated in Table I.

As mentioned, the 2 important factors to determine were the holding time between 145° and 140° F., and the duration of time between

TABLE III

MILK WAS HEATED TO 145° F. IN OPEN VESSEL AND POURED IMMEDIATELY INTO VACUUM BOTTLE OF SAME TEMPERATURE. THE TEMPERATURE OF THE CONTENTS OF THE VACUUM VESSEL WAS RECORDED AT HOURLY INTERVALS

		Pint			Quart	
Hours	½	1	1½	1	2	4
1	117.5	138.5	140.5	141.5	141	137
2	101	133	136	138	137	132
3		128.5	132	135	134	127
4		124	128	132	131	122.5
5		120	124.5	129	129	118.5
6		116.5	121	126.5	127	114.5
7		113	118	124	125	111
8		110	115	122	123	107.5
9		107.5	112	119.5	121.5	103.5
10		104.5	109	117	120	100
11		102	106.5	115	118	97
12				113	117	94
13					115	92
14					114	90
15					112.5	88

140° and 115° F. Table IV gives this in condensed form for the 6 vessels used. These results are averages of 100 experiments outlined in Table I.

It will be seen from Tables III and IV that the 1 quart vacuum bottle is a very efficient instrument for pasteurizing milk. The 2 quart vessel is insulated and the cost is out of proportion to its size when compared with the 1 quart vacuum bottle. The ½ pint and the pint vacuum bottles, and the gallon insulated jug should not be used for home pasteurization for two reasons: (1) the holding time between 145° and 140° F. is too short, and (2) the length of time between 140° and 115° F. is too short for safety.

TABLE IV

LENGTH OF TIME THE MILK WAS SUBJECTED TO PASTEURIZING TEMPERATURES (145° TO 140° F.). LENGTH OF TIME THE MILK WAS HELD AT TEMPERATURES BELOW PASTEURIZATION POINT, BUT BEFORE BACTERIAL MULTIPLICATION BEGAN

	Pint			Quart		
	½	1	1½	1	2	4
Length of time 145° to 140° F.	8 min.	45 min.	1 hr. 5 min.	1½ hrs.	1 hr.	35 min.
Length of time 140° to 115° F.	1 hr. 8 min.	5 hrs. 40 min.	6 hrs. 55 min.	9½ hrs.	12 hrs.	8 hrs. 20 min.

Various bacteria have been added to the milk to test the efficiency of this method of pasteurization. Most of these experiments have been carried out with the quart vacuum bottles. The bacteria were added to 2 quarts of milk, heated to the temperatures indicated, and put into two 1 quart vacuum bottles—1 c.c. samples were removed after 30, 35, 40 and 45 minutes. The results are given in Table V. Each organism was used for 3 experiments and each experiment was run in duplicate; hence, the bacterial counts on each line in Table V represent an average of 6 counts.

We found that the porcine strain of the *B. abortus* was the most resistant of any of the bacteria tested. We have not used the *B. tuberculosis* in these experiments, as there are many observations recorded upon its thermal death point. If the milk is held between 145° and 140° F. for 1 hour there is a wide margin of safety and it will be free of pathogenic bacteria. Table VI is similar to Table V, except that we used the ½ pint vacuum bottle. Tables III and IV show the short period that the milk will be held at pasteurizing temperatures in this small vessel. This accounts for the inefficiency of the ½ pint vacuum bottle (Table VI) as compared to the quart bottle (Table V) for pasteurization purposes.

TABLE V

BACTERIA ADDED TO MILK, HEATED TO TEMPERATURES INDICATED AND PUT IN 1 QUART VACUUM BOTTLE. BACTERIAL COUNTS MADE UPON 1 C.C. SAMPLES AT INTERVALS INDICATED

	No. of Organisms per c.c.	Temp. F. of Milk at Start in Bottle	30 min. Colonies	30 min. Temp. F.	35 min. Colonies	35 min. Temp. F.	40 min. Colonies	40 min. Temp. F.	45 min.
B. Diphtheria	5,000,000	145	0	144					
B. Typhosus	5,000,000	145	0	143.5					
Strep. Epiderm.	4,000,000	143	0	141					
Staph. Albus	9,000,000	144	0	143					
B. Abortus Caprine	2,000,000	145	0	143.5					
B. Abortus Cow	3,000,000	145	0	142.5					
B. Abortus Porcine	5,000,000	142	400	141	0	141	0	141	0
*B. Abortus**	5,000,000	140.5	300	139	40	139	0	139	0
*B. Abortus**	5,000,000	141.5	800	140.5	0	140.5	0	140.5	0
*B. Abortus**	9,000,000	145	0	144	0	144	0	144	0
*B. Abortus**	9,000,000	139	800	138	500	138	0	138	0
*B. Abortus**	25,000,000	147.75	2,000	146	200	146	0	145.5	0
*B. Abortus**	5,000,000	143	0	142					
*B. Abortus**	5,000,000	143	0	142					
*B. Abortus**	5,000,000	145	200	144	0	144	0	143.7	0
*B. Abortus**	2,000,000	145	0	143.5	0	143.5	0	143	0
*B. Abortus**	7,000,000	145	400	144	0	144	0	144	0
*B. Abortus**	5,000,000	145	0	144	0	143.6	0	143.4	0
*B. Abortus**	5,000,000	145	100	143.4	0	143	0	142.6	0

* *B. Abortus Porcine.*

Table VI shows that 115° F. is the lowest temperature at which milk can be held in vacuum bottles before bacterial multiplication begins.

We thought it advisable to use some other indicator for temperatures than the mercury thermometer for the home pasteurization, since initial cost and probable breakage would not aid in the widespread use of this procedure. We have developed two indicators that will replace the mercury thermometer and can be used by the mother in the kitchen. Palmitic acid has a melting point of 145° F. Sealed in an ampule it changes from an opaque to a water clear color when 145° F. is reached. Thin glass tubing 11 mm. in diameter has been made into ampules approximately 45 mm. long, into each of which 400 mg. of palmitic acid was placed, then sealed.

An ampule is dropped into the milk in a pan on the stove. During heating the milk is constantly stirred with a clean spoon. When the floating ampule becomes colorless the temperature has reached 145° F. In our experiments the actual temperature of the milk is seldom less than 147°, and at times 149° F. This is because of exposure of part of the ampule to the air and the poor conductivity of the glass.

TABLE VI

BACTERIA ADDED TO MILK, HEATED TO TEMPERATURES INDICATED AND PUT IN ½ PINT VACUUM BOTTLE. BACTERIAL COUNTS MADE UPON 1 C.C. SAMPLES AT INTERVALS INDICATED

Organisms	Control	Bacterial Colonies 145° F.	140° F.	135° F.	130° F.	125° F.	120° F.	115° F.	110° F.	105° F.	100° F.
B. Typhosus	5,000,000	0	0	0	0	0	0	0	0	0	0
Brucella-cow	14,000,000	3,300	2,300	1,200	0	0	0	0	0	0	0
Brucella-porcine	4,000,000	2,100	2,000	1,500	100	0	0	0	0	0	0
Brucella-caprine	2,000,000	0	0	0	0	0	0	0	0	0	0
Staph. Albus	80,000,000	6,600	2,600	2,200	0	0	0	0	0	0	0

TABLE VII

BACTERIAL COUNTS OF 1 QUART SAMPLE OF FRESH MILK IMMEDIATELY AFTER HEATING AND POURING IN VACUUM BOTTLE AND AFTER TIME INTERVALS NOTED. TEMPERATURES TAKEN AT TIME BACTERIAL COUNTS ARE INDICATED

Hours	At start	3½	6½	9	12	16	21	25	28
Temperature	146.75° F.	140	135	130	125	120	115	110	108
Colonies	300,000	0	0	0	0	300	1,800	7,000	300,000

Inasmuch as the cream line is of no importance in this method we have considered the added temperature of 2 to 4° above 145° advantageous. The second indicator is menthol. A glass tube 4½ mm. in diameter, of approximately 8″ in length, is blown out at one end into a bulb, into which menthol is placed and the open end of the tube sealed. Menthol changes from an opaque substance to a clear fluid at 108° F. This indicator is for the purpose of determining if the vacuum bottle has become an incubator. When it is suspended in the milk and remains opaque the milk is not to be used for human consumption. If it changes to a clear fluid the milk is still safe for use. The equipment necessary to carry out this method of pasteurization will cost less than $3.00. We give the detailed instructions as to the technical procedure.

EQUIPMENT

1. Pan of more than 1 quart capacity with side lip to facilitate pouring of milk from pan into bottle
2. Vacuum bottle of 1 quart capacity
3. Temperature indicator (No. 1) for pasteurization in sausage shaped glass tube
4. Temperature indicator (No. 2) for cooled milk—a long glass tube with bulb on end

PASTEURIZATION TECHNIC

1. Clean out vacuum bottle with hot soap water several times. Rinse well with water about 160° F., fill bottle with this water and let stand.
2. Wash the stopper of the vacuum bottle well, put it in a small pan of water

and boil for 10 minutes. Pour water out of pan carefully, leaving the clean stopper in the empty pan.

3. Clean a pan well and pour 1 quart of fresh clean milk into it. Milk should be free from dirt and less than 12 hours from the cow.

4. Drop indicator No. 1 into the milk. Place pan on the heated stove and bring temperature of milk up rather slowly, stirring constantly with a clean spoon.

5. When the indicator No. 1 becomes transparent, the temperature of the milk has reached 145° F. Remove milk from the stove. Take out indicator No. 1 with spoon and put on table.

6. Pour the hot water out of the vacuum bottle.

7. Pour the hot milk into the heated vacuum bottle. Stopper the bottle.

8. Set the vacuum bottle in a warm cupboard in the kitchen and leave it there until the milk is to be used.

9. Do not use this milk until it has stood in the vacuum bottle for at least 1 hour.

10. Use the indicator No. 2 (with glass stem) to determine whether the milk in the vacuum bottle is warmer than 115° F. Hold the end of the glass tube in the hand and put the opaque bulb down into the milk in the vacuum bottle. Hold it in the milk for 2 to 4 minutes. If it is above 115° F. the bulb will clear. If below it will be opaque.

11. If the milk is at a temperature above 115° F., pour out enough to make a feeding. Replace the vacuum bottle and the remainder of the milk in the cupboard.

12. When the milk in the vacuum bottle becomes cooler than 115°, it should be discarded.

The thermal death points recorded in this experiment have been determined by using the vacuum and insulated bottles. Our problem was to determine the thermal death point of bacteria using the method we have suggested for pasteurizing milk in the home.

One Murder in Year Norway's 1928 Record

UNITED States cities where the murder rate has shown a tendency to jump in recent years might profit by studying conditions in Norway, according to figures presented recently before the Commons Committee on Capital Punishment, which show that Norway had only one murder in 1928.

And the tendency is decreasing, due to abolition of the penalty of capital punishment, M. Kristian Hannson, secretary of the Norwegian prison commission, told the committee.

Growth of culture, a higher standard of living, and better police organization were given by Mr. Hannson as explaining the decrease in crime.

Punishment for premeditated murder in Norway is from 6 to 20 years. Good conduct men can be released after serving two-thirds of their sentence.